# Coronary Artery Disease: A Glimpse Into Reducing the Widespread Burden

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**Background**

Coronary artery disease (CAD), also known as ischemic heart disease and coronary heart disease (CHD), is the most common type of heart disease in the United States and most developed nations across the globe. This is a condition of the coronary arteries, the vessels which supply your heart muscle with oxygenated and nutrient rich blood. Atherosclerosis occurs in the arteries, causing a buildup of a substance called plaque which narrows and eventually completely blocks vital blood flow (Cleveland clinic, 2021). Plaque comes from improper diet and is an accumulation of cholesterol, calcium, fibrin, and other food waste products like nitrates. If there is build up in the coronary arteries, there is more than likely build up in other areas of the body as well, which can lead to additional complications outside of CAD's symptoms (Centers for Disease Control and Prevention: Coronary Artery Disease, 2021). Without proper flow in the coronary arteries, the heart muscle cannot pump blood into the aorta and through the other arteries all around the body, ceasing proper functioning and potentially causing death. CAD is a gradual disease, but can eventually lead to consistent arrhythmia, cardiac arrest, heart failure, and organ dysfunction. Patients with CAD will often experience stable angina, which is periodic chest pain, dyspnea, which is shortness of breath, and fatigue.

Coronary artery disease has an abundance of risk factors which include non-modifiable determinants of age, sex and gender, and behavioral modifiable determinants of hypertension, hyperlipidemia (high levels of low density lipoprotein cholesterol and low levels of high density lipoprotein cholesterol), diabetes mellitus, obesity, smoking, poor diet, low physical activity, and low socioeconomic status (Brown, 2022). As atherosclerosis builds up plaque over time, CAD is a slowly progressing disease which has increased rates the older the age group. Men develop

coronary heart disease at an earlier age than women, approximately 7-10 years prior, and black, Hispanic, Latino, and southeast Asian groups are affected disproportionately (Maas & Appelman, 2010). Additionally, high blood pressure and high levels of LDL cholesterol increase the chances of developing CAD. According to Ariyanti and Besral, "Dyslipidemia and hypertension are established risk factors of prime importance in cardiovascular disease. If these two factors (dyslipidemia and hypertension) are present together, this will accelerate the process of atherosclerosis, thus increasing the risk," meaning these factors together should be targeted (2019). Behavioral risk factors often compound one another and the nonmodifiable, but screening of fasting lipoprotein profile for seemingly at-risk individuals, like those who are obese, have family history, or smoke for example, can catch cases of CAD early. However, many individuals who would most benefit from screening do not have access to care due to socioeconomic status and poverty levels (American Heart Association, 2022). "Poverty has been deemed one of the major societal determinants of cardiovascular disease worldwide," (Jones et al., 2009).

Roughly 20 million Americans, or 7.2% of adults, are affected annually by the disease in some capacity (Centers for Disease Control and Prevention: Heart Disease Facts, 2022). Heart disease in general is the leading cause of mortality in the United States with over 697,000 people in the United States dying every year. Over half of the 697,000 deaths are attributable to coronary artery disease. Aside from the mortality rates, CAD is a major public health concern for many other reasons and creates serious burden on society financially. From 1996 to 2016 anywhere between $72.3-$85.4 billion dollars were spent each year on CAD alone, due to high prevalence rates, pharmaceutical prices, and inpatient service utilization for CAD related crises (Birger et al., 2021). Effective interventions to attack CAD levels are necessary to lower rates of

overall heart disease in the United States and globally, to decrease gross healthcare expenditures, and to improve general population health. Nevertheless, due to the magnitude of CAD as a health issue and the multidimensionality to its risk factors, the disease is not easy to study or target with intervention. The following three studies constitute research regarding coronary artery disease and how to diminish its burden and affects across the first world.

**Article I**

Byrne, Walsh, and Murphy's 2005 study looked at patient perceptions, beliefs, and behaviors regarding coronary heart disease prevention using Leventhal's Self-Regulation Model of illness perceptions. The Self-Regulation Model is an intrapersonal model which examines the emotional and the cognitive component of disease risk on the patient's outcomes. This model builds off prior developed intrapersonal models like The Theory of Reasoned Action and Theory of Planned Behavior, adding in an emotional element on top of the cognitive and behavioral portion of disease influence (Postolica et al., 2018). Leventhal's model postulates that illness perceptions and beliefs greatly influence emotional and physical coping processes with the disease. 5 components comprise the Self-Regulation Model and they are as follows: beliefs about disease identity, beliefs about disease timeline, beliefs about the personal consequences of the disease, beliefs about what causes the disease, and beliefs about their own control over the disease. This model has been deemed effective for chronic illnesses like coronary artery disease and for diseases which can be affected by primary and secondary prevention measures (Byrne et al., 2005).

The first aim of this research study was to describe the perceptions and beliefs of individuals with coronary heart disease about their medications. Secondly, the study sought to

determine secondary prevention behaviors, like quitting smoking or improving diet, which varied and how these varied by patient cognitions and emotions towards the disease. Postal questionnaires based on the Illness Perceptions Questionnaire (IPQ) were completed by 1,084 CAD patients in this cross-sectional style study, and additional data was gathered from medical charts to test the hypothesis that healthier secondary prevention behaviors would be associated with stronger perceptions of control over the disease, stronger beliefs in severity of the disease, and strong beliefs in lifestyle issues primarily causing the disease. Additionally, researchers hypothesized that following proper medicine regimes after CHD diagnosis would be positively associated with the aforementioned components.

Sampling was stratified and random throughout general practices in Western Ireland. Patients at the practices were considered eligible for the study if they had a history of heart attack, angina, or coronary heart disease related surgeries like coronary artery bypass grafting. The mailed questionnaire had 3 topic sections, lifestyle factors, demographic information, and illness and treatment perceptions. Lifestyle factors examined included behaviors like smoking, alcohol consumption, and exercise. Typical demographics were taken, with a large focus on socioeconomic status and income level. Illness and treatment perceptions, as stated previously, were based from the IPQ. There are nine components of this questionnaire: identity, timeline, consequences, personal control, treatment control, illness coherence, timeline cyclical, emotional representations, and cause of disease. Identity refers to the symptoms a patient believes go along with CAD. Timeline is the patient's perceptions of the timeline of the disease, i.e., how long they have before it worsens. Consequences are the ideas a patient has about the effects of the disease as they age. Personal control is how an individual believes they can control their illness. Treatment control is the perceived efficacy of their treatment plan. Illness coherence is defined

as how well patients understand the symptoms of their illness. Timeline cyclical is the perceived cyclical nature of the illness. Emotional representations are the emotions a patient associates with CHD. And finally, cause is defined as perceptions of the root of disease.

Using SPSS statistics and hierarchal multiple regressions, researchers found that demographically the sample came from lower socioeconomic groups, and many were out of work due to retirement or sickness. Nonrespondents and respondents were statistically very similar in all regards besides one; more respondents had been diagnosed with angina than nonrespondents. This reassures that nonresponse bias is at a minimum. Overall, the study found that variations in secondary preventative behaviors were only weakly to moderately correlated with illness perceptions, medication beliefs, and adherence to treatment. This finding does not follow suite with the findings of previous studies which determined illness perceptions to be effective predictors for health behaviors. The only strong components of the SRM found for CAD in this study was emotional representations and the perceptions of one's behavior as a cause for disease development.

These results, although not what expected, do have important implications. Due to the nature of CAD being a disease that many adults live with, often without even realizing, the Self-Regulation Model may not be the most effective to inform prevention programs and interventions. The emotional component of the SRM makes it a great model to choose when considering very emotionally triggering and volatile disease like cancer or ALS. Since CAD is more gradual and not socially regarded as scarily as cancer may be, using other health perception models like the Health Belief Model may be better fit. Additionally, perception and threat of symptoms was found to be very low in this sample of patients, and these are also important

components of the SRM. Incorrect model choice could provide reason for conflicting information found as opposed to other studies in the same domain. Researchers did find that even in the absence of perceived threat of symptoms, informing patients of the potential risks of disease progression could benefit overall outcomes. With the smaller sample size, studies with greater statistical power are necessary to make further conclusions on the topic.

**Article II**

Next, Zhu's 2014 randomized control trial looked at the effectiveness of a Transtheoretical Model based exercise intervention on behaviors of sedentary patients with coronary artery disease. The Transtheoretical Model, also referred to as the Stages of Change Model, is another intrapersonal theory of health behavior. This model is comprised of 5-6 stages, each with characteristic behaviors associated. Precontemplation is the first stage, characterized by individuals who are unaware or unbothered by a particular health issue, and unwilling to make any change within the next 6 months. The second stage, contemplation, is defined by an intention to make change in the next 6 months and a newfound understanding of the health risks of remaining stagnant. Preparation, also known as determination, is when individuals are finally ready to take action, within the next 30 days at most, and have a plan to start their new behaviors. Action refers to taking the steps to carry out the plan and change the behaviors. Individuals have made the change and are continuing to move forward with the changes within a 6-month period. After 6 months, one reaches the maintenance stage where behavior change is sustainable and intent to continue the behavior is high. This stage is focused on preventing relapse. Finally, termination is a 6$^{th}$ stage sometimes included in definitions of the Transtheoretical Model. Termination includes the lack of desire to return to any unhealthy behaviors and no chance of

relapse. This is very rarely reached in health behaviors and therefore often not included when creating health intervention and promotion programs (LaMorte, 2022). Additionally, the Transtheoretical Model looks at the processes needed for change at each stage, the self-efficacy required at each stage, and decisional balance.

Cardiac disease patients often benefit from exercise-based rehabilitation, but adherence to exercise regimens is always drastically low due to several factors. Zhu et al., state that "only 3.8% to 38% of patients with CHD participated in formal cardiac rehabilitation programs. Of those who participated in such programs, the dropout rate reached approximately 50% during the first six months," although participants who do complete the programs have much better outcomes (Zhu et al., 2014). Research on how to improve adherence to exercise programs is necessary. Since the Transtheoretical Model has been found to be incredibly effective regarding behavioral changes, this model is a great basis for intervention programing.

For this study, 196 sedentary angina pectoris and/or myocardial infarction participants were randomly assigned to three different treatment groups, one being a control group, one being a basic physical education group, and one being the Exercise Stage-Matched Intervention (ESMI). The control group received conventional care which is provided to patients in an outpatient setting. The physical education group included a two-hour educational session, a pamphlet with information on the benefits of exercise for cardiac rehabilitation, and 8 sessions of general patient education about exercise, two of which must have been in person. The ESMI group received conventional care, a 2-hour patient education session, a pamphlet with information on the benefits of exercise, and eight weekly sessions of the exercise stage matched interventions. "According to the TTM, the strategies and techniques used to motivate individuals

in the precontemplation or contemplation stage to change their behavior are different from those in the action or maintenance stage," and therefore, The ESMI created by researchers takes into account the stage an individual is along the transtheoretical framework and informs exercise strategies based on that phase. Patients were all monitored weekly to ensure compliance. Researchers included a chart with the stage of change, goal, processes, and strategies and techniques utilized during this study. For example, researchers had the goal to increase awareness of the need to change for individuals in precontemplation. Processes included consciousness raising, dramatic relief, environmental reevaluation, and self-reevaluation. Strategies were providing education about risks of sedentary lifestyle, providing information about physical activity benefits, giving personalized risk factor feedback, discussing emotional perceptions of exercise, and overall encouragement at this stage for this example.

The Exercise Stages of Change Scale determined participants' placement in the transtheoretical framework. The Exercise Self-Efficacy Scale was an 18-item questionnaire regarding patient confidence towards their physical activity behaviors. Finally, the Exercise Benefits Scale and Exercise Barriers Scale each determined decisional balance of participants. These scales all showed high internal consistency rates with Cronbach's alphas of greater than .96 for each. Patients were also required to log their daily activity, and researchers determined intensity by Borg's Rating of Perceived Exertion Scale. Survey data for the conventional, physical education, and ESMI groups was analyzed using chi square tests for nominal data and one-way ANOVAs.

46 of the 196 patients withdrew or were lost to follow up, however no significant difference was found between the demographics of the sample and the withdrawn group. More

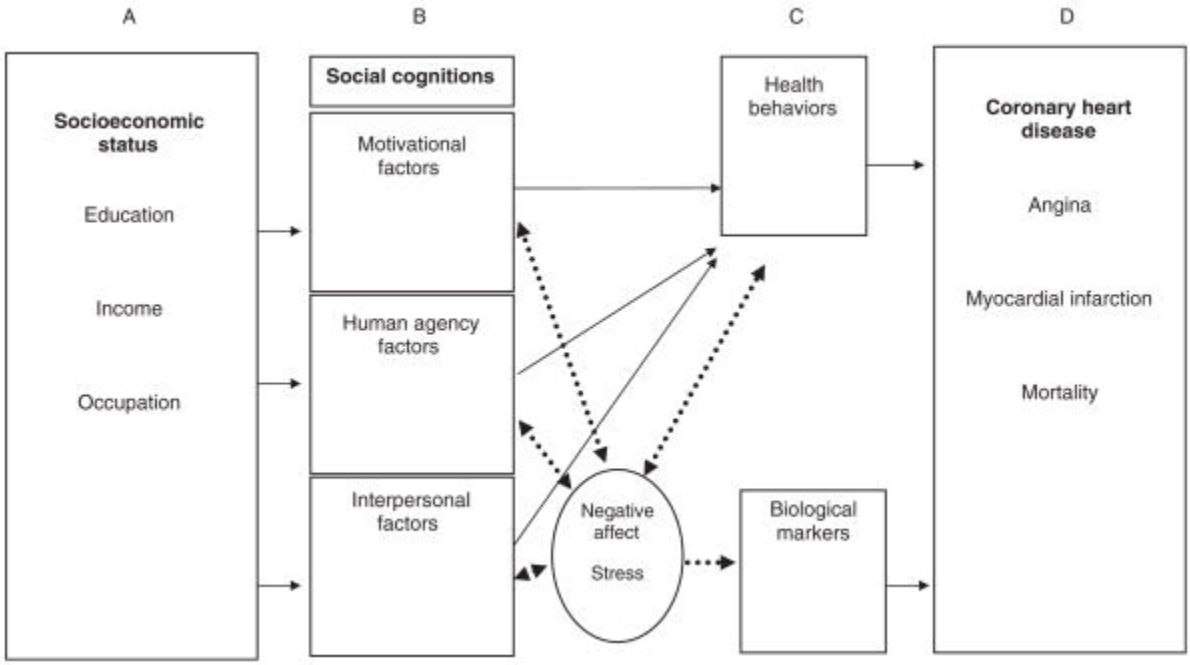
patients in the ESMI group had progressed through at least one Stage of Change after the 8-week period than the conventional and physical education group. Further, the ESMI group had higher improved self-efficacy and decisional balance than the other two groups. Moderate exercise duration was greater for ESMI patients as well. There were significantly more positive changes for the transtheoretical based approach than either of the other two which persisted at 3 and 6 month follow up points. As the physical education group received all the same care as the ESMI group, minus the stage-based intervention, this sample matched design improves the statistical significance and decreases risk of confounding.

Findings are limited due to the plausibility of self-report biases and potential selection biases. Using the Transtheoretical Model was a great choice of model and effectively aids in improving cardiac patient outcomes. Further studies could look at transtheoretical model-based approaches in conjunction with life course theory. Analyzing whether specific life course factors influence the effectiveness of exercise-based interventions for cardiac patients could help to eventually alleviate the disease burden on the most vulnerable populations.

**Article III**

Finally, Phillips and Klein's 2011 meta-analysis considered the impacts of socioeconomic status on coronary heart disease. Socioeconomic status plays a huge role in overall health and wellbeing of an individual. Differing social groups defined by race, ethnicity, gender, education, etc. all have drastically different health issues and health outcomes over the lifetime. Economic status and level of education achieved compound these differences. Socioeconomic status combines the effects of 3 major components and determinants of health: healthcare access, environmental exposures, and personal health behaviors (Adler & Newman,

2002). “Recent advancements in cardiovascular health have primarily benefitted wealthier, better-educated individuals, while progress among those of lower socioeconomic standing continues to lag,” according to Phillips and Klein (2011). Associations of socioeconomic status and coronary artery disease span all the areas of socioeconomic status, but the direct mechanisms which link the two were sought out by this study. Researchers hypothesized that the psychosocial factors of socioeconomic status directly cause coronary artery disease in some individuals, giving the example of a patient sfrom lower socioeconomic environments having diminished self-esteem, sense of control, and orientation towards mastery and efficacy due to the types of jobs they would work.




Researchers postulated the above model of the social cognitive pathways that affect coronary artery disease. Firstly, socioeconomic status, comprised of education, income, and occupation directly lead to social cognitions, or the beliefs that people hold about themselves and their environment. Social cognitions are further divided into motivational factors, human agency

factors, and interpersonal factors. Motivational factors are made up of attitudes and beliefs of an individual regarding a health behavior, in this case a behavior which either increases or decreases risk of coronary artery disease. Human agency factors are the perception of one's ability to make changes to their environment, social or physical. Constructs of perceived control, self-efficacy, and attribution are found in this section. Finally, social factors include social norms, perceived discrimination, stereotype threat, and social comparison act as either facilitators or inhibitors to risk of heart disease. The simplest pathway moves from motivational, human agency, and interpersonal factors to health behaviors and then finally risk of coronary heart disease. Motivational factors, human agency factors, and interpersonal factors all work together to change an individual's negative affect and stress level. However, stress level and negative affect can also work backwards to have an affect on the previously mentioned factors. Eventually, negative affect and stress alongside biological markers and health behaviors add up to total risk of developing CHD.

Looking at the findings, researchers firstly found that lack of occupational control, which links directly to low social class and socioeconomic status, is correlated with CHD risk. However, higher beliefs in one's personal control has also been consistently linked to greater coronary artery disease, possibly due to unrealistic ideas of personal control. This construct, called the locus of control yields inconsistent results for cardiac patients, discrediting the hypothesis. However, regardless of the locus of control construct, negative affect and emotions are associated both with low socioeconomic status and CAD, as well as limited educational level. Additionally, those in lower occupational groups were found across many studies to have higher odds ratios for developing CAD than higher groups. Regarding biological risk factors, socioeconomic status shows correlation with development of hypertension, high blood pressure,

and cardiovascular reactivity to stressful situations. Inversely, socioeconomic status associates with interpersonal and social status factors which also associate with the biological components and risk factors for CAD. These biological markers prime patients and directly lead to CHD as shown in the model. Higher social status, self-efficacy, and other interpersonal factors help to moderate stress and the autonomic nervous system and therefore lower cardiovascular reactivity. Additionally, members of lower occupational, educational, and economic status ranked themselves as lesser than other members of society. This negative social comparison is related to negative biological markers of coronary heart disease like higher central adiposity for example. Stereotype threat, the fear that one will conform to the larger group, and perceptions of discrimination are related to race, socioeconomic status, and therefore cardiac outcomes. Literature further suggests that patient mistreatment by providers has been linked to race and socioeconomic status, which combines to create even greater risk. Additionally, behaviors like physical activity, poor dietary, and smoking and alcohol-based behaviors directly cause or alleviate coronary artery disease. Research has found some linkages between these behaviors and socioeconomic status as well like the model suggests.

Majority of the studies considered by this meta-analysis were cross sectional or correlational in nature, however the few which examined causal associations did find causation to appear between many of the socioeconomic factors discussed and CAD. Additionally, many of the studies referenced demonstrated effects for the motivational, human agency, and interpersonal factors even when the others were controlled for as confounders. This alludes to an amalgamation of effects of each factor separately and all together for CHD. As this is a systemic review, research analyzed is global and includes many types of measurements and questionnaires. This can be seen as a benefit as the researchers had many perspectives, but also a

limitation since the research methods are not standardized. Other limitations included not effectively evaluating intention in relation to health behavior and using a unidimensional scale of perceived control, as perceptions of control can be both internal and external. Additional studies looking at socioeconomic status and heart disease could try to factor in the accumulation of risk model with correlated insults. This model looks at related adverse exposures across the life course and takes into account the timing and aggregation of insults concerning a particular health outcome. Determining the chain of risk and timing of certain socioeconomically linked determinants could aid primary prevention efforts and help to inform intervention programs based on the level of risk.

**Conclusion**

Coronary artery disease and heart disease in general are dependent on effective prevention and intervention programs informed by public health policy and health research. The studies included in this review indicate findings surrounding the topic and areas necessary for further study. Comprehensively, the rates of coronary heart disease in the United States and across the developed world is due to multifaceted, multi-layered, complex health risk factors. Health theory and determinants of health can help to deepen science's understanding of CHD and alleviate the burden on healthcare systems, communities, and families alike.

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